CARDIOVASCULAR SYSTEM[1]

I. INTRODUCTION

A. OUTLINE OF CONDITIONS COVERED

The cardiovascular system can be divided into the following groups of disorders to facilitate consideration of functional capacity and the ability to perform the duties of a patrol officer.

GROUP	EXAMPLES OF GROUPS
Arrhythmias	PVCs, Atrial Fibrillation, Heart Block, PAT, Brady/Tachy, WPW, Pacemaker
Valvular Disease	Mitral Valve Prolapse, Rheumatic Valve Disease, Bacterial Endocarditis, Congenital Valve Disease
Congestive Failure	Cardiomyopathy, IHSS
Inflammatory Disorders	Myocarditis, Pericarditis, Endocarditis
Coronary Disease	CABG, Angioplasty-Atherectomy, Myocardial Infarction, Angina
Hypertension	All Levels of Control

The examination and evaluation protocol described in this section organizes the above cardiovascular conditions into those that cause: (1) symptomatic heart disease; (2) asymptomatic heart disease; or (3) produce abnormal test results. A separate section on hypertension is presented.

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B. IMPLICATIONS FOR JOB PERFORMANCE

The patrol officer position includes a variety of physically and emotionally demanding job duties that have a significant impact on cardiovascular functioning. Patrol officers engage in vigorous activities requiring above-average degrees of fitness and cardiovascular reserve, such as:

- running up to 500 yards at full speed;
- moving incapacitated persons and other heavy objects in excess of 100 feet; and
- subduing combative subjects after pursuit running.

Aerobic capacity refers to the maximum amount of oxygen an individual can consume within a given period of time (VO_2 max). The aerobic capacity needed to perform law enforcement tasks such as wrestling can easily be 40-41 ml/kg/min., or 12 METS (see Respiratory chapter). In fact, extremely vigorous activities, such as pursuit and combat with multiple suspects, or running up an embankment or several flights of stairs, may require an even higher degree of aerobic capacity.

The amount of time that a person can continuously perform work at a given oxygen requirement depends upon the percent of the person's VO_2 max needed to do the job and his/her state of conditioning. The average person can work at his/her VO_2 max for approximately 1-3 minutes; at 80% of his/her VO_2 max for 15-30 minutes, etc. An individual's oxygen requirements must be considered in light of the fact that physically demanding patrol officer activities have been found to be in excess of two minutes in duration.

II. MEDICAL EVALUATION AND EXAMINATION GUIDELINES

A. GENERAL SCREENING RECOMMENDATIONS

Candidates with heart disease must be individually considered to determine their diagnosis, prognosis, and functional capacity. This information should be evaluated to determine if candidates can perform patrol officer duties in a safe and efficient manner without exacerbating their cardiac condition.

1) History:

See Medical History Statement. Syncope, chest pain, dizzy spells or loss of balance, and other symptoms of cardiovascular disease require complete evaluation to determine cause and risk of recurrence.

2) Examination:

The physical examination should include an evaluation for signs of congestive heart failure (e.g., edema, rales, and increased jugular venous pulse), assessment of the heart sounds and rhythm, and a characterization of all supplemental sounds and murmurs.

All candidates should have their blood pressure measured in the sitting position. The cuff should be properly zeroed and should be at least as wide as 2/3 of the length between the antecubital fossa and the axilla, and should wrap around the arm at least 1 1/2 times (Kirkendall, et al., 1980; Frohlich, et al., 1987). Elevated values require repeat testing to determine reliability.

3) Routine Tests:

All candidates should have a resting EKG and chemistry panel to identify those in need of lifestyle modification to delay onset of cardiovascular disease. While routine tests should not be used to qualify or disqualify candidates, they are useful in determining the need for exercise testing and lifestyle modification.

B. EVALUATION OF COMMON CLINICAL SYNDROMES

1) DIAGNOSED HEART DISEASE - SYMPTOMATIC:

Cardiovascular symptoms, such as chest pain, fatigue, and shortness of breath or dizziness, indicate a decrease in the heart's functional capacity in terms of its ability to successfully meet the body's requirement for oxygenated blood.

The New York Heart Association system (1963) for classifying cardiovascular diseases includes both functional (Table I-1) and therapeutic (Table I-2) categories. As indicated

in these tables, functional classes II - IV are symptomatic with activity, and therapeutic classes B - E require restricting activities to those that involve less than maximal exertion. Therefore, individuals falling within either of these classification ranges would be unable to safely perform the more strenuous patrol officer activities (e.g., subduing combative subjects, running 500 yards). For example, the functional classification (representing the heart's ability to deliver an adequate amount of oxygenated blood to the body) indicates that those in Class II are unable to perform activities that require a maximum oxygen consumption of more than 22 ml 0_2/kg/min. (6 METS). Since activities such as wrestling require performance at a level of 12 METS or greater, a Class II individual would be unable to safely perform these activities (Sidney & Blumchen, 1990).

TABLE I-1
New York Heart Association Cardiovascular Classification System
Functional Classification

Class I:	Ordinary physical activity does not cause fatigue, palpitation, dyspnea or anginal pain. Maximum oxygen consumption is 22 ml or more 0_2/kg/min.
Class II:	Cardiac disease results in slight limitation of physical activity. Maximum oxygen consumption is 16 ml to 22 ml 0_2/kg/min.
Class III:	Cardiac disease results in marked limitation of physical activity. Maximum oxygen consumption is 10 ml to 16 ml 0_2/kg/min.
Class IV:	Cardiac disease results in inability to do any physical activity without discomfort. Maximum oxygen consumption is less than 10 ml 0_2/kg/min.

Adapted with permission from Criteria Committee of the New York Heart Association. 1964. Diseases of the Heart and Blood Vessels: Nomenclature and Criteria for Diagnosis, 6th ed. Boston: Little Brown and Company.

TABLE I-2
New York Heart Association Cardiovascular Classification System
Therapeutic Classification

Class A:	Individuals with cardiac disease whose physical activity need not be restricted.
Class B:	Individuals with cardiac disease whose ordinary activities are not restricted, but are advised against competitive or severe efforts.
Class C:	Individuals with cardiac disease whose physical activities should be markedly restricted.
Class D:	Individuals with cardiac disease whose physical activities should be severely restricted.
Class E:	Individuals with cardiac disease whose physical activities should be at complete rest in a chair or bed.

Adapted with permission from Criteria Committee of the New York Heart Association. 1964. Diseases of the Heart and Blood Vessels: Nomenclature and Criteria for Diagnosis, 6th ed. Boston: Little Brown and Company.

2) DIAGNOSED HEART DISEASE - ASYMPTOMATIC:

It is occasionally necessary to recommend that asymptomatic individuals with heart disease limit their activities to those that require no more than moderate dynamic or static exertion (6 METS) (Cheitlin, et al., 1985). For example, IHSS is an important cause of sudden death in young adults; it is therefore recommended that individuals with this condition limit their activities to those equivalent to low intensity sports (i.e., those with low dynamic and low static demands: 3-4 METS; Mitchell, et al., 1985).

Consideration must be given to the individual's ability to withstand the sympathetic assault associated with recurrent emergency responses to life-threatening situations. Asymptomatic individuals require testing to determine their functional capacity and associated risks. Echocardiography might reveal, for example, that an individual with IHSS has marked left ventricular hypertrophy or evidence of significant obstruction of left ventricular outflow. Ambulatory monitoring may show significant cardiac arrhythmias, and cardiac stress testing may reveal inappropriate blood pressure response, arrhythmia, cardiac ischemia, or poor physical conditioning.

3) NO CONDITION DIAGNOSED, BUT ABNORMAL FINDINGS OR RISK FACTORS:

Occasionally, routine testing identifies an individual with no diagnosed condition but abnormal test results. It is common to find individuals with occasional PVCs, abnormal heart sounds, or a mild heart murmur, the significance of which is unknown. Individuals who present with such findings require further diagnostic testing to determine if functional impairment or risk of sudden incapacitation is present. Examples include: hypertension with left ventricular hypertrophy, IHSS, severe three vessel disease or high grade stenosis of the left main coronary artery, cardiomyopathy with decreased ejection fraction, recurrent ventricular tachycardia, aortic stenosis, and significant valvular insufficiency.

C. RECOMMENDED EVALUATION PROTOCOL

Individuals with cardiovascular disorders or those with abnormal findings usually present a clear picture of the types of activity that can or cannot be performed. Work and recreational activity should be discussed completely to determine whether symptoms are present at rest or with activity. Recency, intensity, duration, frequency, and the type of activities should be documented. Medications taken in the past or at present require consideration of side effects. Cardiac medications may cause dizziness, paresthesia, incoordination, change in mental status, or weakness and fatigue (Kruyer & Hickman, 1990). Beta blockers may effect maximal exercise capacity and compromise performance during a critical incident.

Candidates with a known cardiovascular disorder should submit copies of medical records for review. Date of onset and progression of the disorder, response to treatment(s), and examples of functional ability are often available from these records.

When baseline testing presents abnormal results without concomitant symptoms, risk factors for cardiac disease such as smoking, diabetes, hypertension, high cholesterol, and family history of heart disease before age 55 should be reviewed.

Some or all of the following tests should be considered to determine functional ability:

1. Exercise EKG - Maximal Exercise Testing: Normal fitness without arrhythmia, ischemic change or hypertensive response should be present. Table I-3 demonstrates the relationship between functional class, METS, oxygen requirements, and level of exercise. (As discussed earlier, the more demanding patrol officer activities require the ability to exercise at 12 METS.) If blood pressure increases to greater than 200 systolic or 100 diastolic during or after exercise, an echocardiogram is recommended to rule out left ventricular hypertrophy.

   Note: In cases where a standard exercise EKG is not helpful (such as when LBBB or LVH are present, or when the exercise EKG is ambiguous) a Thallium treadmill should be performed.

2. Echocardiography: Valvular disease, decreased ejection fraction, hypertrophy, or chamber enlargement confirms the presence of significant cardiovascular disease that will limit the candidate's ability to safely engage in strenuous police activities. Color flow doppler may be helpful in determining the functional significance of valvular abnormalities.

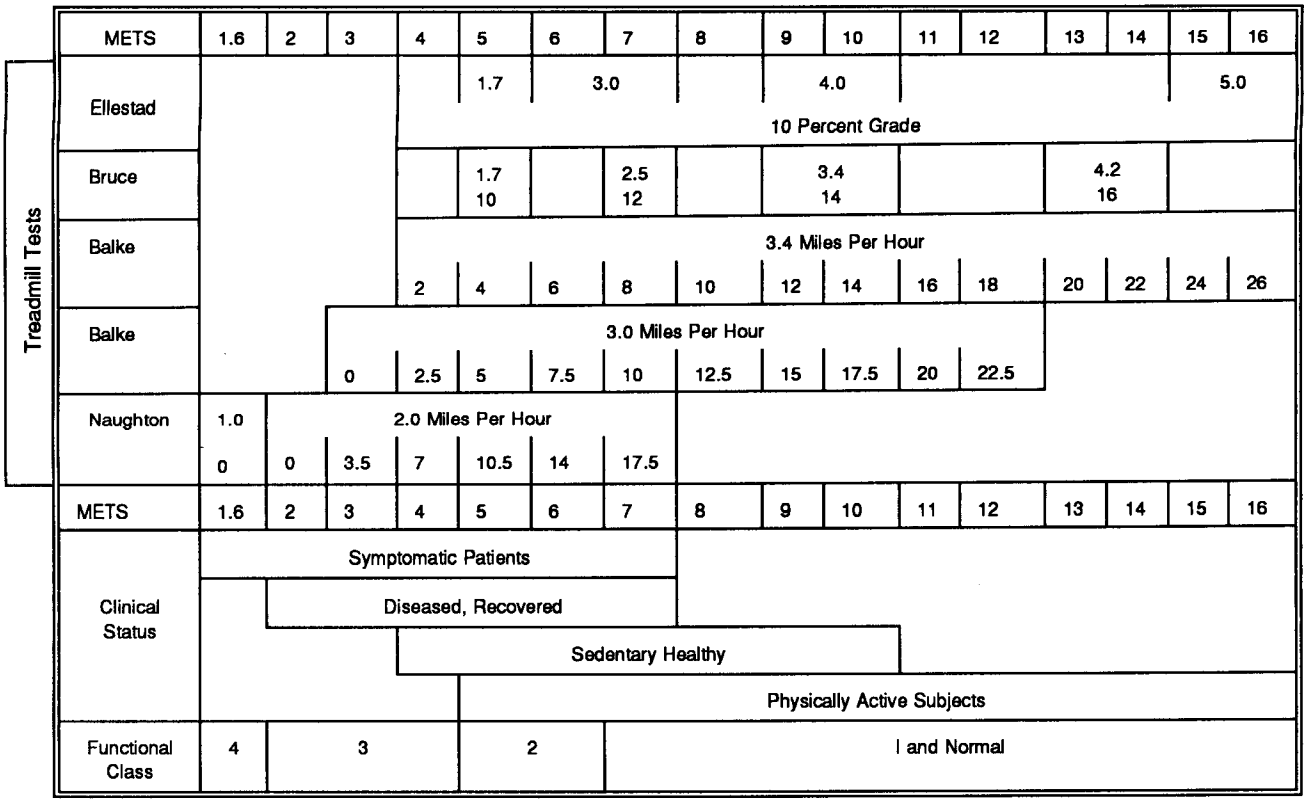
3. Holter monitor (24 hr.): No complex arrhythmia or arrhythmia that may be associated with fatigue, dizziness or loss of functional ability should be found. Candidates with frequent premature beats require diagnostic testing to establish the cause of the arrhythmia and to determine functional limitations and therapeutic regimen.

4. Exercise 2D Echo: Sensitivity of 61-86%; specificity of 75-100% for myocardial ischemia (decreased E.F./ segmental wall motion changes).

5. Electrophysiologic Study: Symptoms of arrhythmia, documented arrhythmia, or conditions such as WPW require specific study to determine the nature of the arrhythmia and the risks posed by the condition.

6. Cardiac Catheterization: Catheterization study may be required to demonstrate patent arteries to all regions of the heart when other studies are not diagnostic, when history suggests intermittent spasm, or when there is a history of coronary disease or previous surgery.

TABLE I-3
Relationship of METS and Functional Class According to 5 Treadmill Protocols



In the Ellestad protocol, the numbers in the boxes are miles per hour (mph); in the Bruce protocol the top numbers are mph and the bottom numbers are the percent grade. In the Balke and Naughton protocols the numbers are the percent grade. Adapted with permission from Fox, S.M. III, Naughton, J.P., and Haskell W.L. 1971. Physical activity and the prevention of coronary heart disease. Annals of Clinical Research. 3:404-432. Copyright 1971 The Finnish Medical Society Duodecim.

In conclusion, candidates with cardiovascular disease must be symptom-free to perform the more strenuous job duties of patrol officer. Moreover, even asymptomatic individuals with cardiovascular disease may be found to lack the physical capacity to perform the required job duties, or may be therapeutically restricted from performing maximal physical activities. Therefore, it is imperative to use functional testing to ensure that job-related physical activities can be performed in a manner safe to both the individual and the public.

III. HYPERTENSION

Three or more blood pressure readings above 90 mmHg. on successive examination days are required to make a diagnosis of hypertension. Blood pressure levels as classified according to the diastolic reading (the most frequently used classification method) are defined as: Mild 90 - 104 mmHg.; Moderate: 105 - 114 mmHg.; Severe: 115 mmHg. and above. Systolic hypertension refers to systolic blood pressures consistently above 140 mmHg. (Frohlich, et al., 1987).

Hypertension is the most common disease affecting the heart and blood vessels. Essential hypertension (i.e., no known cause) affects an estimated 60 million adults in the United States (Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, 1984). Other forms of hypertension are relatively uncommon (5-10% of cases) and can be hormone related or associated with diseases of the kidney. While most individuals with essential hypertension can achieve control pressures (below 90 mmHg.) through diet, exercise, behavior modification and medication, there is no cure for the disease and control becomes a lifelong effort. After normal levels of pressure are achieved, it may be possible to reduce the amount of medication, but rarely is it possible to discontinue treatment altogether (Schmieder, et al., 1991).

A. GENERAL CONSIDERATIONS

Stressors:

Certain psychological situations and physical activities are particularly dangerous for the hypertensive individual. Job stress, such as situations in which the individual is "caught in the middle" may produce or exacerbate high blood pressure (Ely & Mostardi, 1986).

Physical activities that demand repeated high levels of static strength until fatigue halts the activity can produce acute blood pressure elevations and, when left ventricular dysfunction is present, can result in serious cardiac dysrhythmias. Blood pressure elevations can be more extreme and sustained for those with hypertension than for the non-hypertensive under the same circumstances (Zabetakis, 1984). Strenuous patrol officer activities, such as pushing vehicles, lifting heavy objects, moving incapacitated persons, and subduing combative subjects are likely to worsen hypertension (Mustacchi, 1990). Situations that cause a threat to life, fear of severe bodily harm, serious confrontational situations, and/or responsibility for the life and welfare of others are among those that have been identified as maximally stressful to individuals (Graham, 1945).

Complications:

The complications of hypertension can be severe and even fatal. Severe hypertension can cause cerebral edema, headache, vomiting and stroke. The degree of

hypertension can rapidly progress to severe levels as a result of physical or mental stress. Aggravation of hypertension can cause irreversible and rapidly progressing damage to the arteries of the heart, brain or kidneys, leading to heart attack, stroke or kidney failure.

The prognosis of untreated hypertension is extremely poor. Mortality is increased with the severity of hypertension. The average diastolic blood pressure in men at age 45 years is 78 mmHg.; the mortality rate of this group is 300% greater than normal if average pressure is elevated to 152/95 (mild hypertension) and remains untreated. Blood pressure, rather than age, appears to be a more significant factor in the mortality rate. By the time a typical hypertensive individual develops complications, s/he has already survived three-fourths of his/her hypertensive life span.

It has been demonstrated, however, that treatment of even mild hypertension makes dramatic changes in prevention of major morbidity and mortality from stroke, heart disease, kidney failure, and retinal disease.

Medication:

Use of anti-hypertensive medications commonly produces side effects that vary in nature and severity. Multiple effects may be experienced by an individual as additional medications are required to achieve control (Croog, et al., 1986).

Commonly experienced side effects include sleepiness, fatigue, dizziness, cough, severe nasal stuffiness, gout or hypotension from over treatment. Problems of control result from patients discontinuing medication because of side effects. Additionally, mild to moderate hypertension is often asymptomatic, leading many individuals to discontinue medication or to ignore other treatment programs (Cramer, et al., 1989).

B. RECOMMENDED EVALUATION PROTOCOL

All candidates should be questioned regarding the onset of their hypertension, events associated with high readings, current and past medications, side effects from medication, and family history of hypertension. Compliance with prescribed medical treatment should be verified.

Candidates with hypertension requiring medication for control should have their blood pressure measured in the sitting, standing, and lying position to rule out orthostatic hypotension. Pupil dilation to permit evaluation of the fundus for hypertensive retinopathy is necessary.

Urinalysis should be performed with special attention paid to the presence of protein or red blood cells as an indicator of renal disease with secondary hypertension. EKG at rest should be evaluated for signs of ventricular hypertrophy.

GROUP I: NORMAL BLOOD PRESSURE READINGS

If there is no evidence of hypertension, no restrictions are necessary.

GROUP II: MILD HYPERTENSION (OVER 160 mmHg. SYSTOLIC OR 90-104 mmHg. DIASTOLIC) IS PRESENT OR BLOOD PRESSURE IS CONTROLLED (LESS THAN 90 mmHg. DIASTOLIC) ON MEDICATION OR DIET

An exercise EKG should be performed. If diastolic blood pressure remains below 100 mmHg. throughout testing, and systolic blood pressure remains below 200 mmHg., no activity restriction is necessary if exercise is completed through at least 12 METS of activity (Stage 4 Bruce protocol) and no evidence of ischemia or arrhythmia is found. However, candidates with diastolic blood pressure rising 10 mmHg. or more, or whose systolic blood pressure reaches 200 mmHg. or more with exercise are demonstrating a hypertensive response to stressful physical activity and should be restricted from engaging in job duties requiring this level of activity.

GROUP III: MODERATE HYPERTENSION (105-114 mmHg. DIASTOLIC) OR SEVERE HYPERTENSION (115 mmHg. DIASTOLIC AND ABOVE)

The risk of incapacitation and injury to the candidate or others is significant and medical treatment is required. The candidate should be restricted from performing activities which are physically demanding and/or have public health and safety implications.

Note: The World Health Organization and International Society of Hypertension recommend that diastolic blood pressures of 90 mmHg. or above should be repeated at least twice over the subsequent 4 week period of time. Those with results over 100 mmHg. should commence drug treatment. Those with values below 100 mmHg. should commence behavioral intervention and observation for 3 months. If after 3 months their values are still in excess of 95 mmHg., drug treatment should be considered; those below this level should continue with behavioral intervention and observation.

Given the above guidelines, it is possible that candidates may move from one of the above groups with treatment, or when treatment is altered or abandoned. The evaluation protocol should therefore begin after the candidate has shown stability for at least 3 months in Group I or II.

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